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Perception of Farmers Towards the Use of Modern Beehives Technology in Amhara Region, Ethiopia

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Abstract: The study was sought to ascertain determinants of adoption of modern beehives technology in North Gondar zone. A multi stage sampling method was employed to select 130 sample farm households using probability proportional to size. Descriptive statistics and binary logit model were used for analyzing the quantitative data. The results of this study indicated that 33 (25.6%) of the sampled beekeepers were adopters, whereas the remaining 96 (74.4%) were non-adopters. The determinant factors affecting adoption of the technology were analyzed by logit model and the result showed that, education, off-farm income, availability of credit, beekeeping training and perception in the price of box hives were important factors influencing adoption of modern beehives technology in the study area. Demographic variables like sex and age, farmer's participation in peasant association (PA) administration, land holding size, participation of new technologies and labour availability were less powerful in explaining farmer's adoption of modern beehives technologies that indicates the two groups were homogeneous with regard to these variables. Thus, special adult education programs must be promoted and expanded in rural areas as a precondition for facilitating technology adoption and awareness training supported by practical demonstration must be arranged to farmers before any technological intervention is taken place either by government or non-governmental organizations. In addition credit should also be given as a part of the package for the proper adoption of the technology.

Key words: Adoption % Beekeeping % Determinants % Modern Beehives Technology

INTRODUCTION

Ethiopia is one of the countries of the continent that has the largest honey bee population and a big potential of honey production due to its varied ecological and climatic conditions. Ethiopia is home to some of the most diverse flora and fauna in Africa that provide surplus nectar and pollen to foraging bees [1].

Ethiopia is one of the largest countries in Africa both in terms of land area (1.1 million km^2) and population of 70.7 million. The Ethiopian economy is based mainly on agriculture which provides employment for 85 % of the labour force and accounts for a little over 50 per cent of the GDP and about 90 per cent of export revenue [2].

Although difficult to establish a time reference when beekeeping was started in Ethiopia, it may date 5000 years back and the Hieroglyphs of ancient Egypt refers to Abyssinia (the former name of Ethiopia) as the source of honey and bee wax. Thus Abyssinia has been known for its bee wax export for centuries whenever other items were not exportable [3]. Increasing population pressure and small and decreasing land holdings necessitated intensification of production practices in agriculture particularly in livestock products and productivities are highly demanded to meet the increasing demand for food [4]. Beekeeping is therefore one of the major areas of intervention for poverty alleviation in Ethiopia [5].

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Ethiopia has a share of around 23.58% and 2.13% of the total Africa and world honey production, respectively. The country is the leading honey producer in Africa and one of the 10 largest honey-producing countries in the world, cited by [6]. Beekeeping for instance, does not require fertile land as well as large area. Males and females of all working age groups can practice it. It also requires little initial capital. However, the products obtained from honeybees are low and unstable due to several technical and socio-economic constraints [7].

Amhara regional state has recently put apiculture development in its priority development agenda as one of the strategies to reduce poverty and to diversify national exports. In the last ten years bureau of agricultural and rural development of the region has given special attention for beekeeping development in the honeybee sub-sector, because it plays an important role in income generation for beekeepers [8], NGOs like SOS sahel, Agri-service Ethiopia, are also giving more attention to the sub-sector than ever before as an important intervention areas to support the poor and particularly women. As a result, large number of improved beehive technologies have been introduced and promoted by the regional bureau and other nongovernmental organizations over the past 10 years [9]. The most common modern beehives are box hives, casting mould, honey extractor, honey presser, smoker, water sprayer, veil, glove, etc. Since 2006, in North Gondar zone which is the study area more than 8 thousand box hives have been produced and distributed to the district agricultural and rural development offices to be redistributed to farmers. However, it is observed that the amounts of modern beehive technologies used by farmers were very limited. It has been found that farmers' perceptions of technology specific attributes affect the decision for adoption beyond other factors [10]. But earlier adoption studies have rarely considered the effect of perceptions in adoption decision. Moreover, it is not known a prior what combination of factors have influence on farmers' adoption decision process as the socioeconomic, technical, institutional and biophysical settings of the farmers are subject to continuous changes over space and time [11].

Although attempts have been made to improve the adoption and productivity of beekeeping by various organizations, some social, ecological and climatic factors, as illustrated in Figure 4.3, were identified as constraints which hinder farmers from adopting the available beekeeping technologies [12].

Therefore, adoption of modern beehives technology may be affected by many personal, socioeconomic, institutional and technology related factors. Understanding factors influencing the adoption of use of technologies largely contributes to improving intervention strategy [13]. Farmers' perceptions of technologies are equally important in adoption decisions and thus deserve research attention. Hence, determinant factors affecting adoption of the technology is not investigated rigorously at least in the study area. Thus the research is initiated to address the identified knowledge gap [14]. The objective of the study is therefore, to identify determinants of adoption of modern beehives technology by smallholder farmers in the study area.

MATERIALS AND METHODS

Data Types and Data Collection Methods: Both qualitative and quantitative data was collected from primary and secondary data sources. Qualitative data was used to assess smallholder farmer's attitudes towards the use of modern beehives technology in the study area and were collected through personal observation, focus group discussions and key informant interviews. Semi-structured questionnaire was prepared and collected quantitative data in the study. The questionnaire was pre-tested to evaluate for consistency, clarity and to avoid duplication and to estimate the time requirement during data collection.

A multi stage sampling method was employed during the study and the first three stages out of the 24 districts of North Gondar zone were selected purposively based on the assumption to represent each agro-ecological zone. The samples were also categorized in to higher, medium and lower modern beehive technology distributor districts. Data for high, medium and low performing district was taken from North Gondar zone, department of Agriculture. In the second stage two technology user peasant associations from each District were also be selected purposively on the basis of the fact that PAs with a wider exposure to modern beehives technology. In the third stage, random sampling on the basis of proportional to size was employed to select 130 farm households from the respective PAs. Then, adopters and non-adopters were identified from the sample farm households at each PA. Here adopters are those who used at least one component from the modern beehives technology in the study area.

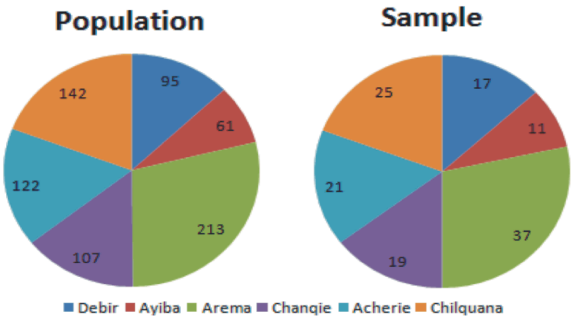

Fig. 1: Sample farm households from 6 peasant associations in 3 Districts

Source: Field survey, 2011

Both qualitative and quantitative data were analyzed and appropriate tools and techniques of analysis were employed. Qualitative data were obtained by observation, focus group discussion; key informant and group interview were organized and described in the process of field work and quantitative data was analyzed using descriptive statistics. To compare adopters and non-adopters of modern beehives technology *t-test* and *chi* square test were conducted. Ultimately, binary logit econometric model which best fits the analysis of determinant factors that affect adoption of modern beehives technology was also employed.

RESULTS AND DISCUSSION

The rural household's adoption of technologies was influenced by demographic, socio-economic, institutional and psychological factors. Adoption of modern beehives technology by farm households to the context of this study was therefore, measured in terms of modern bee hives technology users and non-users. The results of the study indicated that 33 (25.6%) of the sampled farm households were found to be adopters, whereas the remaining 96 (74.4%) were non-adopters. The average age of the household heads was 43.5 years, with minimum and maximum ages of 18 and 83 years respectively. The average age of adopters and non-adopters was 43.71 and 42.72 years respectively that was similar to the total average age of the respondents. In addition, the age category of adopters and non-adopters were 18-64 years and 22-83 years respectively (Table 1).

With regard to sex the sample was composed of 97.7% male headed households and the remaining 2.3% female headed households. This significance difference is due to the large portion of the society in the study area is male headed households. It was also identified that all female headed households from the sample were non-adopters.

About 51.94 percent of the sample households were literate and the remaining were illiterates. From the total adopter farm households, 75.76 percent were literate and 24.24 percent were illiterate. This may probably mean that literate farmers have more exposure to the external environment and information access which helps them easily associate to technology sources and this was true also to female headed households. According to the survey result all female headed households were non-adopters and also all of them were illiterate.

The study revealed that 26.04% of the non-adopters did not attend any formal education but they could read and write. The remaining 10.42% and 7.29% of the non-adopters had an educational level of 1-4 and 5-8 grade schooling, in the same order. Where as in relation to adopters 24.24% of respondents cannot read and write, 33.34% can read and write and the balance 24.24%, 15.15% and 3.03% had an educational level of 1-4, 5-8 grade and more than grade 8, respectively. From the total sample farm households 36 (27.9%) were found as a participant in the community leadership activities at different positions but the rest didn't. The share of farmer position holders among the adopters group was 39.39% which was less than the non-adopters group.

The result of the study indicates that less than a quarter of the sample farm households were involved in off-farm activities and the rest didn't. From the adopters category 21.21% of the farm households and 13.54% from non-adopters were involved in off-farm activities. It was hypothesised that those farmers involved in off-farm/non-farm activities were able to relieve financial constraints to purchase inputs such as improved bee forage seeds and fertilizers which were the components of modern beehives technology.

As indicated in (Table 1) from the total respondents only 22.5% of them were received agricultural credit during the survey season, but the rest could not. Among the credit beneficiaries category, more than half of the adopters and 10.42 percent of the non-adopters group were gaining formal credit for the purchase of modern beehives technology.

Farmers were asked to compare box hives and other beekeeping technologies with traditional hives and implements in terms of cost, ignoring other parameters. The survey result revealed that the farmer's perception about the prices was an important factor which influences

Table 1: Different characteristic of sample farm household heads

			NA (N=96)		A (N=33)		Total	
	Characteristics		N	%	N	%	N	%
Sex	Male		93	96.87	33	100	126	97.7
	Female		3	3.13	0	0	3	2.3
Education	Literate		32	43.75	25	75.76	67	51.94
		Read and write	25	26.04	11	33.34	36	27.9
		Grade 1-4	10	10.42	8	24.24	18	13.95
		Grade 5-8	7	7.29	5	15.15	12	9.3
		Above grade 8	0	0	1	3.03	1	0.78
Illiterate		54	56.25	8	24.24	62	48.07	
PA administration responsibility		Yes	23	23.96	13	39.39	36	27.9
		No	73	76.04	20	60.61	93	72.1
Involvement in Off/non-farm activity		Involved	13	13.54	7	21.21	20	15.5
		Not involved	83	86.46	26	78.79	109	84.5
Formal credit		Obtained	10	10.42	19	57.58	29	22.5
		Not obtained	86	89.58	14	42.42	100	77.5
Expensive price of modern beehives		Yes	21	21.88	24	72.72	45	34.88
		No	75	78.12	9	27.28	84	65.12
Beekeeping training		Yes	20	20.83	18	54.54	38	29.46
		No	76	89.17	15	44.46	91	70.54
Participation in extension package		Yes	49	51.04	26	78.79	75	58.14
		No	47	48.96	7	21.21	54	41.86

Key: A= adopters, NA= non adopters, SD= standard deviation

households expected utility from investing on new technologies. Thus, from this study it was identified that the majority of the non-adopters group have responded that the prices of modern beehives technology were expensive, but with regard to the adopters group it was the minority that responded as the price of the technology was expensive (Table 1) below.

Farmers were interviewed whether beekeeping training was provided for them before this interview period or not. Hence, from the total respondents only 29.5% were trained about beekeeping management. This figure was 14% from the adopters and the remaining 15.5% from the non-adopters group. When compared trained farmers from the same category it was revealed that 54.54% among the adopters were trained about beekeeping. However, from the total non-adopters only 20.83% were trained (Table 1).

The number of respondents who participated in the extension package program was 58.14%. As the figures in (Table 1), indicated that, out of the total adopters of modern beehives technology, 78.79% of them were participating in any other extension packages that may have given them more experience to accept this agricultural technology. However, the number of participants from the non-adopters was only about 51.04%.

Farm Size: Farm size was thought to be a good proxy indicator of wealth status the farmers in the country. The size of land distribution between adopters and non-adopters is on average 3.9 hectares and 3.1 hectares for adopters and non adopters correspondingly (Table 2). The respondents have the land size which ranges from zero to thirty hectare with the mean of 3.31ha. It is greater than the national average land size, which is 1.5ha. The result shows that both categories have nearly equal size of land.

Availability of Family Labour: Family labour greater than 14 and less than 65 years was expected as an active working labour in the household. The average family labour of adopters and non-adopters of modern beehives technology was different (Table 2). Though adopters had greater mean value of family labour as compared to non-adopters, the mean difference among the two categories were not significant.

Determinants of Adoption of Modern Beehives Technology

Descriptive Statistics of Selected Variables: In order to have a clear picture of the quantitative demographic, socio-economic and institutional variables which differentiate between adopters and non-adopters of

Table 2: Mean distributions of respondents by land holding size

	NA (N=96)		A (N=33)	
Characteristics	Mean	SD	Mean	SD
Land holding size	3.1	3.96	3.9	5.16
Family members >14 years age	2.32	1.39	2.64	1.58

Table 3: Significant discrete variables

		Modern beehives			
Variables	Value	A	NA	Chi-square value	P-value
Participation in local administration	Yes	13(39.4)	23(24)	2.908*	0.071
	No	20(60.6)	73(76)		
Education	Literate	25(75.8)	42(43.8)	10.079***	0.001
	illiterate	8(24.2)	54(56.2)		
Access to credit	Yes	19(57.6)	10(10.4)	31.341***	0.000
	No	14(42.4)	86(89.6)		
Beekeeping training	Yes	18(54.5)	20(20.8)	13.431***	0.000
	No	15(45.5)	76(79.2)		
Input price perception	Yes	24(72.7)	21(21.9)	27.958***	0.000
	No	9(27.3)	75(78.1)		
Experience in extension package	Yes	26(78.8)	49(51)	7.768***	0.004
	No	7(21.2)	47(49)		

Source: Survey result 2011

***, * represent level of significant at 1% and 10% level respectively

Numbers in parenthesis indicates percentages

modern beehives technology *t-test* and *chi-square* test was applied. No continuous and six discrete variables were found significant with 1% and 10% probability level. Only these significant variables are described in (Table 3) below. The independent variables that were significantly influencing adoption of modern beehives technology are discussed below. It was revealed in the study that, 39.39% of the adopters and 23.96% of the non-adopters were peasant association (PA) position holders. The percentage difference among the two categories was significant at 10% level. Because of their access to different information sources PA leaders have adopted better as compared to non-adopters.

From the total respondents 51.9% were literate and the remaining was illiterate. But with regard to adopters and non-adopters about 75.8% of the adopters and 43.8% of the non-adopters group were literate. The percentage difference between adopters and non-adopters in terms of literacy was significant at 1% significance level. It was found that from the total sample farm households 22.5% of the respondents were the only beneficiaries of the existing credit opportunity. This was mainly in accessibility of credit that may originate from poor collection of previous debts as perceived by respondents. The remaining 77.5% of the respondents have not used the credit. The percentage difference among adopters and non-adopters in terms of credit use was significant at 1% significance level. Credit programs may enable farmers to purchase inputs or acquire physical capital, needed for technology adoption [15]. In other words, farmers may reject not to use technologies because of lack of capital and this can be resolved by availing credit from different sources. Therefore, the availability of credit facilitates for technology adoption in particular for farm technologies like beekeeping, which the farmers perceive the technology to be costly to engage in the activity.

From the results of this study, it was revealed that 29.46% out of the sample respondents and 54.54% among the adopters were trained about beekeeping. However, from the total non-adopters only 20.83% were trained. This percentage difference between the two categories was statistically significant at 1% level. This implies that training has a positive contribution to adopt the technologies since the proportion of the adopters who were trained was much higher than non- trained adopters. Training is very important to create awareness and develop confidence of farmers on the technology as well as to make the beneficiary more productive. In the study area, it was provided trainings to farmers about beekeeping and beekeeping technologies by governmental and non-governmental organizations in the last years.

The prices of modern beehive technologies were increased year after year like other commodities in the country. Therefore, the farmer's perception about the prices is an important factor which influences the activities expected utility from investing on new technologies. From the results of this study it was identified that 72.72% of the non-adopters group have responded that the price of modern beehives technology were expensive, but only 21.88% of the adopters group. Sample farm households perception towards this technology was having a significant difference at 1% level among the two categories.

It was hypothesized that earlier participation in any agricultural extension packages would help farmers to accumulate experiences and develop new practices that will encourage farmers to test and further adopt new technologies [16]. 78.8% of the adopters and 51% of the non-adopters group are found as a participant in different agricultural extension packages before they were adopting the beehives technology. The percentage difference among adopters and non-adopters were significant at 1% level. This implies that the more the farmer tries new technologies on his/her farm, the more he/she will have experience in testing other technologies.

Model Output: In the preceding section, variables characterizing the farm households and their differences among the adopters and non-adopters were identified. However, in the logit model analysis, we emphasize on considering the combined effect of variables between adopter and non-adopter farm households in the study area. Therefore, the emphasis is on analyzing the variables together, not one at a time. By considering the variables simultaneously, we are able to incorporate important information about their relationship.

From the total variables, eleven variables five of the variables were found to be significant. The remaining six were less significant in explaining the variations in the dependent variable and two variables did not show variation among sample farm households. The maximum likelihood estimates of the logistic regression model show that education, off-farm income, availability of credit, bee keeping training and perception in the price of box hives were important factors influencing adoption of modern beehives technology in the study area (Table 4). Demographic variables (sex and age), farmers participation in PA administration, landholding size, participation of new technologies and labour availability were less powerful in explaining farmers adoption modern beehives technologies indicating that the two groups were homogeneous with regard to these variables.

Farmer’s perception on the relative price of modern beehives technology was found to be an important variable in adopting the technology. The Wald statistics corresponding to the variable show that it is significant at 1%level. The odds favouring adoption of modern beehives technology increases by a factor of 0.674 for farmers who perceived the price of the input was not expensive. This is consistent with the prior expectation. The explanation is that the price of box hives and other accessories is increasing from time to time, thus, the farmer's perceive that it is too expensive to farmers which influences the expected utility from investing on the new technologies.

It was also apparent from the results that beekeeping training would increase adoption of modern beehives technology. The odds favour adoption of improved technologies increases by a factor of 0.727 for households who participated in beekeeping training programs. The positive relationship between trained farmers and adoption of the technology is that farmers who have clear information about the use and the method of implementing the technologies had the highest opportunity to adopt the technology. This study is consistent with [17] who empirically tested that developing the skill of beekeeper through beekeeping training enhanced adoption of improved box hive.

Availability of credit to purchase agricultural technologies is another factor, which is significantly related to the dependent variable and that it is significant at 5% probability level. The odds in favour of adopting modern beehives technology increases by a factor of 0.653 for availability of formal credit to purchase agricultural inputs. The reason behind this is that those farmers who had access to credit sources will be able to buy modern beekeeping equipments better than others that who didn’t have access to credit. Farmer’s involvement in off-farm/non-farm activities will relieve their financial constraints to purchase inputs such as modern beehives equipments. Therefore, the results of the logit model show that this variable affects adoption of modern beehives technology positively and significantly. The odds in favour adoption of modern beehives increase by a factor of 0.745 for households who had involved in off-farm/non-farm activities. Education is assumed to increase farmer's ability to obtain process and use information relevant to the adoption of improved technologies. As prior expectation education affects adoption of modern beehives technology positively at 5% significance level. The odds in favour of adopting modern beehives technology increased by a factor of 0.723 for farmers who had more educational level.

Table 4: Logistic regression for factors affecting adoption of modern beehives technology

Explanatory variables	Estimated coefficient	Odds ratio	Wald statistics	Significances level
Sex	17.816	2.035	.000	.999
Age	.019	.030	.393	.531
Participation in local administration	.373	.688	.293	.588
Education	1.852	.723	6.559**	.010
Off/non-farm activity involvement	-1.478	.745	3.936**	.047
Farm size	.078	.058	1.775	.183
Access to credit	-1.557	.653	5.685**	.017
Experience in extension package	.210	.807	.068	.794
Beekeeping training	-1.536	.727	4.465**	.035
Labour availability	.325	.260	1.554	.212
Input price perception	-2.655	.674	15.536***	.000
Constant	-17.642	2.035E4	.000	.999

, * significant at $p<0.05$ and $p<0.01$

CONCLUSION AND RECOMMENDATION

The results of the study revealed that most of the technology adopters were literate as compared to non-adopters that implies literate farmers have more exposure to the external environment and information which helps them easily associate to technology sources the findings agrees with the reports of [18]. Thus, special adult education programs must be promoted and expanded in rural areas as a precondition for technology adoption. Farmer's training about the technology arranged in this case about modern beehives technology has a positive contribution to adopt it since the proportion of the adopters who were trained was much higher than non-trained adopters as identified from this study and this result similar with result of [19]. Hence, awareness training supported by practical demonstration must be arranged to farmers before any technological intervention is taken place either by government or non-governmental organizations.

In this study it was identified that most of the non-adopters group have responded that the price of modern beehives technology were expensive as compared with few numbers of the adopters group and the result agrees with report of [20]. In addition the majority of the non-adopters group were not accessed to formal credit. These conditions hindered farmers not to use box hives. Therefore, credit should be arranged as a part of the package for the proper adoption modern bee hives technology similar finding reported by [21].

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REFERENCES

1. Chala, K., T. Taye, D. Kebede and T. Tadele, 2012. Opportunities and challenges of honey production in Gomma district of Jimma zone, South-west Ethiopia.
2. Central Statistical Agency (CSA), 2003. Livestock resources and production Statistics in Ethiopia. Federal Democratic Republic of Ethiopia Agricultural Sample Survey for 2003. Report on Livestock and Livestock Characteristics. Statistical Bulletin. Volume II. Addis Abeba, Ethiopia.
3. Gezahegne, T., 2001. Beekeeping (In Amaharic), Mega Printer Enterprise, Addis Ababa, Ethiopia.
4. Kigatiira, K.I., 1985. Apiculture and apicultural research in Kenya. Proceedings of 3rd int. conference in apiculture in tropical climates, Nairobi, pp: 33-38.
5. Bhusal, S.J. and R.B. Thapa, 2005. Comparative study on the adoption of improved beekeeping technology for poverty alleviation; Journal Institute of Agriculture and Animal Sciences, 26: 127-135.
6. Gidey, Y. and F. Kibrom, 2010. "Beekeeping for rural development: its potentiality and constraints in eastern Tigray, Northern Ethiopia". Agricultural Journal, 5(3): 201-204.
7. Amhara Region Agricultural Research Institute (ARARI), 2008. Beekeeping in the Amhara region: Bahar Dar, Ethiopia.

8. Christopher, B., F. Barrett and A. Abdullahi, 2002. The challenges of stimulating adoption of improved natural resources management practice in Africa agriculture. Management in African agriculture, understanding and improving current practice. CABI publishing is a division of CAB International, Wallingford, Oxon, OX10 8DE UK.
9. Akinwumi, A., G. Adesina, K. Jojo and F. Baidu, 2001. Farmers' perceptions and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa Farmers' perceptions and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa. ELSEVIER Agricultural Economics, 13: 1-9.
10. Degnet, A., 1999. Determinants of Adoption of HYVs of Maize in Jimma Zone: The case of Mana and Kersa Districts. M.Sc Thesis. Alemaya University. Ethiopia.
11. Jones, R., 2006. Beekeeping. In: P.D. Paterson, The tropical agriculturalist. pp. vi-viii. Keeping bees in fixed-comb and movable-comb frameless hives. Apiculture in Tropical Climates, IBRA, London, 9-13. Reprinted in 1981.
12. Cramb, R.A., 2003. “Processes Affecting the Successful Adoption of New Technologies by Smallholders”. In: B. Hacker, (ed). Working with Farmers: The Key to the Adoption of Forage Technologies, pp: 11-22. ACIAR Proceedings No. 95. Canberra: Australian Centre for International Agricultural Research.
13. Shariff, A., A. Zaharim and K. Sopian, 2009. The comparison between logit and probit regression analyses in estimating the strength of gear teeth. European Journal of Scientific Res., 27(4): 568-583.
14. Zegaye, T., G. Taye, D. Tanner, H. Verkuijl, A. Agidie and W. Mwangi, 2001. Adoption of improved bread wheat varieties and inorganic fertilizer by small-scale farmers in Yelma Dansa and Farta Districts of northern Ethiopia. www.cimmyt.cgiar.org/research/ Economics /.../N We stern Eth.pdf.
15. Monga, K. and A. Manocha, 2011. Adoption and constraints of beekeeping in District Panchkula (Haryana), India. Livestock Research for Rural Development. Volume 23, Article #103. Retrieved June 15, 2011, from http://www.lrrd.org/ lrrd23/5/ mong23103.htm.
16. Agwu, A.E., J.N. Ekwueme and A.C. Anyanwu, 2008. Adoption of improved agricultural technologies disseminated via radio farmer programme by farmers in Enugu State, Nigeria. African Journal of Biotechnology, 7(9): 127-186.
17. Workneh, A., 2007. Determinants of adoption of improved box hive in Atsbi Wenberts Districts of eastern zone, Tigray region. M.Sc. Thesis, Haramaya University, Ethiopia.
18. Kerealem, E., 2005. “Honeybee production system, opportunities and challenges in Enebse sar midir woreda (Amahara region) and Amaro special woreda (SNNPR), Ethiopia”. Unpublished M.Sc. Thesis, Alemaya University, Alemaya.
19. Farinde, A.J., K.O. Soyebo and M.O. Oyedokan, 2005 Exploration of Bee keeping as a coping strategy in a deregulated economy. Journal of Agricultural Extension Vol. 8: Improving Productivity and Market Success (IPMS). Enterprise gender fact sheet; Apiculture, Atsbi PLW, Tigray Region, Ethiopia.
20. Adeday, G., M. Shiferaw and F. Abebe, 2012. Prevalence of Bee Lice *Braula coeca* (Diptera: Braulidae) and Other Perceived Constraints to Honey Bee Production in Wukro Woreda, Tigray Region, Ethiopia. Global Veterinaria, 8(6): 631-635.
21. Belay, D., T. Azage and B.P. Hegde, 2012. Smallholder Livestock Production System in Dandi District, Oromia Regional State, Central Ethiopia. Global Veterinaria, 8(5): 472-479.